The protected Transylvanian Blue (*Pseudophilotes bavius hungarica*): new information on the morphology and biology

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Abstract. *Pseudophilotes bavius hungarica* (Diószeghy, 1913) is an endemic subspecies from Transylvania with a distribution restricted to steppe-like habitats. It is included as a protected entity in Romanian and European legislation. The present study reveals new data on the morphology and biology, host plants, and behaviour of this taxon and tries to provide a basis for developing conservation measures in the future.

Introduction

The Transylvanian Blue, *Pseudophilotes bavius hungarica* (Diószeghy, 1913), is mentioned in the annexes II and IV of the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, the European Red List of Butterflies (van Swaay et al. 2010), in the Romanian legislation (OUG 57/2007 approved with amendments by Law 49/2011 on the protected nature reserves, natural habitats, wild flora and fauna), and the Red List of Romania (EN) (Rákosy 2002).

The conservation status of this taxon is due to the restricted distribution of its populations in Romania. The Transylvanian Blue can only be found in areas with steppe-like vegetation and presence of the larval host plant *Salvia nutans* L. (Lamiaceae) (Kovács et al. 2001). One of the known populations in Transylvania, considered to be the healthiest, is located in Suatu (Cluj County), in and around the botanical nature reserve (Fig. 1).

As conservation efforts need to be based on a good knowledge of the characteristics and behaviour of the taxon in question, and as previous data (Jutzeler et al. 1997, König 1992) were incomplete, we provide new information about the morphology of the egg, larva, and adult and the biology of this protected taxon.

Materials and methods

The study was conducted at two sites (each 9500 m^2) with high densities of *S. nutans* in and around the Suatu botanical nature reserve. In these locations we systematically collected and observed all stages in the development of *P. bavius hungarica*.

The pre-adult developmental stages and the adults were observed and studied both in the laboratory and in the field between April 15 and June 15, 2010 and 2011. During the same period, larval host plants, flight pattern, oviposition preferences, host plant

phenology, and meteorological parameters were recorded daily for 60 minutes with time being randomised to avoid systematic effects of the time of day.

Twenty-seven larvae, together with their host plant (in pots) and the respective closest ant colony were transferred and reared in the laboratory. These larvae were fed and observed daily for 120 minutes to analyse their mobility, myrmecophily, and parasitism. The ants and parasites were sent to specialists for identification.

For a more accurate description of the taxon, detailed photographs (macro and scanning electron micrographs) of the eggs, larvae, and pupae were taken.

Results and Discussion

Taxonomy

The name *Pseudophilotes bavius hungaricus* was often erroneously used in the literature, as for example in all editions of "A field guide to the Butterflies of Britain and Europe" (Higgins & Riley 1970, 1978; Tolman & Lewington 1997, 2008) and in "Verzeichnis der Schmetterlinge Rumäniens" (Rákosy et al. 2003). We wish to emphasize that the correct name of this taxon is *Pseudophilotes bavius hungarica* as it was originally described by Diószeghy in 1913 under this name.

P. bavius hungarica is completely isolated, both ecologically and geographically, from other subspecies of *P. bavius*, the closest being *P. bavius egea* present at a distance of about 200 km southeast of the Carpathian arch (Dincă et al. 2011a). Due to this isolation, the question arose whether it would be appropriate to change the taxonomic status from subspecies to species. However, the hypothesis that these taxa are conspecific was rejected by molecular studies comparing *P. bavius hungarica* and *P. bavius egea*, which revealed a rather weak genetic differentiation between them (Dincă et al. 2011b).

Morphology

E g g . The eggs are laid between the unopened hairy flower whorls of the host plant. The colour of fresh eggs is whitish. They are in the shape of a flattened sphere with a slightly deepened micropylar area, a diameter of 0.50–0.62 mm and a height of 0.25–0.28 mm. The chorion shows a characteristic reticulate structure (Fig. 2). The micropylar rosette is made up of more or less regular polygonal cells (Fig. 3). The size and the shape of the egg were first described by König (1992) and Jutzeler et al. (1997).

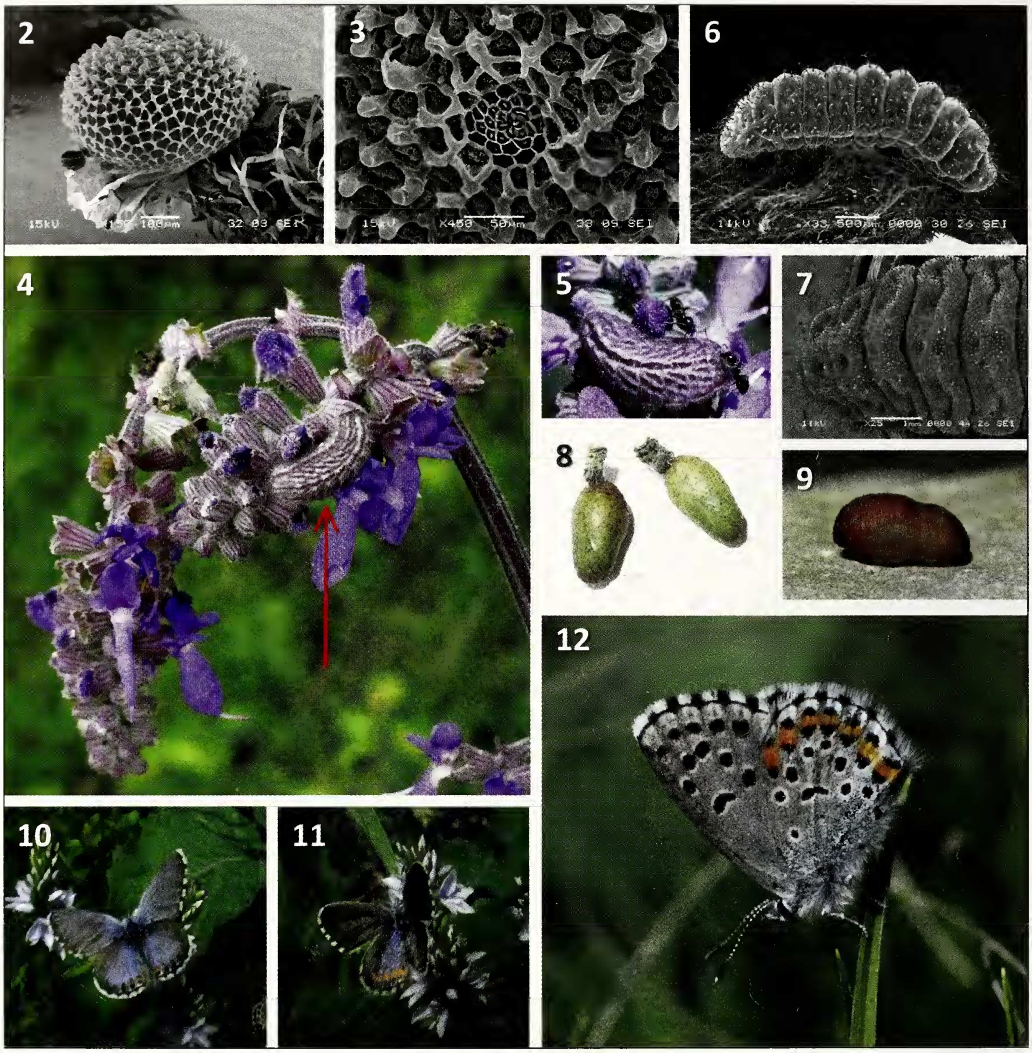
L a r v a . After a short period of embryonic development (7–12 days), whitish, very mobile, 2.5 mm long larvae emerge and climb into the growing flower spikes. Our observations confirm those of König (1992) about the duration of the larval stage, which extends over 25–30 days. After the first moult, the larva changes its shape and colour; on the flattened and, at both ends, rounded body a horizontal line and many diagonal lateral lines appear, and the colour becomes very similar to that of the host plant (König 1992) (Figs 4–5). On the larval body several lateral rows of long hairs can be observed (Fig. 6), as well as two rows of subdorsal hair pairs and a double row of dorsal hairs,

Fig. 1. Terraces with flowering *Salvia nutans* at Suatu – suitable habitat for *P. bavius hungarica*.

which are shorter and more visible in later larval developmental stages (Fig. 7). Both field and laboratory observations showed that the last instar larvae have a lower mobility, but they still move from one floret to another without leaving the host plant.

P u p a . The mature larva climbs down the host plant onto the ground in order to pupate and prepares a pupation site by binding together sand, fine gravel and plant material with a silken thread (König 1992). The pupal colour varies from a light brownish-green in the beginning of this stage (Fig. 8), to a dark brown colour by the end of the pupal stage (Fig. 9). The pupa is barrel shaped with a length of 7–9 mm (7–8 mm was indicated previously by Jutzeler 1997) and a width of 4–5 mm (König 1992). Pupation takes place on the ground next to the host plant (König 1992). The pupae were kept in the laboratory for 280–290 days and the butterflies emerged in the first ten days of April.

A d u l t . The average wingspan resulting from measuring 20 males and 24 females was 22.24 mm ± 1.29 SD for the males and 22.35 mm ± 2.35 SD for the females. The smallest individual had a wingspan of 17.2 mm (female) and the largest of 25.1 mm (also a female). The upperside of the wings in males has a more pronounced blue colour with a metallic iridescence and a row of orange spots narrower than in females (Fig. 10). The dorsal area of the forewing in females is darker and has less of a blue metallic iridescence and the row of orange spots on the hindwing is more intensly marked (Fig. 11). The row of orange spots on the hindwing is more intensly marked on the ventral side of the wings in both sexes (Fig. 12). There is individual variability, especially in the size and the number of the orange spots on the upper- and underside of the hindwing, and in the size of the black spots on the underside of both wings.



Figs 2–3. Scanning electron micrographs (SEM) of the *P. bavius hungarica* egg (photos by Mihali): **2.** General view. **3.** Detail of micropylar rosette. **Figs 4–5.** *P. bavius hungarica* larvae: **4.** Larva before pupation perfectly camouflaged in the *Salvia nu-tans* flowers. **5.** *P. bavius hungarica* larvae visited by *C. atricolor* ants. **Figs 6–7.** *P. bavius hungarica* larva (SEMs by Mihali): **6.** Second larval instar. **7.** Detail of dorsal view. **8.** Fresh pupae of *P. bavius hungarica*. **9.** Mature pupa of *P. bavius hungarica* (photo by Gascoigne-Pees). **Figs 10–12.** Imago of *P. bavius hungarica*: **10.** Male. **11.** Female feeding on *Veronica prostrata.* **12.** Ventral view.

Biology

Pseudophilotes bavius hungarica larvae are monophagous, feeding exclusively on *Salvia nutans*. In laboratory conditions they also accept *S. pratensis* L. (Jutzeler et al. 1997).

P. bavius hungarica is a monovoltine species; the flight period of the adult starts at the end of April, but depending on the particular climatic conditions each year, it can vary significantly. In the time interval 1910–2010 the earliest observed beginning of the flight period was reported by Diószeghy (1913) on the 20th of April in Vițe. In 100

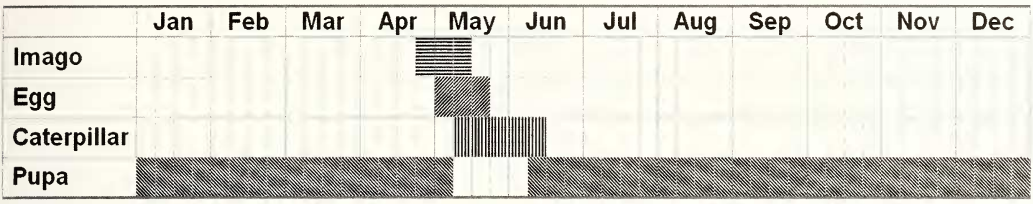


Fig. 13. Developmental stages of *P. bavius hungarica*.

years of observations of the populations of *P. bavius hungarica* from the Transylvanian Basin no earlier beginning of its flight period has been recorded. In 2011, when the month of April was extremely dry and warm, the first individuals were observed on the 18th of April. Usually, the flight period lasts for 15–17 days. However, climatic disturbances can break or derange the flight period, leading to its extension of up to four weeks. The last individuals were observed on the 17th of May. Twenty-seven larvae, together with their host plant (in pots) and the respective closest ant colony were transferred and reared in the laboratory. These larvae were fed and observed daily for 120 minutes to analyse their mobility, myrmecophily, and parasitism. The ants and parasites were sent to specialists for identification. For a more accurate description of the taxon, detailed photographs (macro and scanning electron micrographs) of the eggs, larvae, and pupae were taken.

During our field observations we noticed that the flowers of *S. nutans* appeared later and in fewer numbers in 2011 compared to 2010. This change might explain the observed oviposition preferences of the adults in 2011. Thus, on the flower whorls we found 10–11 eggs in 2011, compared to 3–5 eggs in 2010. As a consequence, the number of larvae observed on a single flower whorl was also higher in 2011 (maximum of five) compared to 2010 (maximum of two). In this context, it has to be noted that the number of observed *P. bavius hungarica* individuals was low in Suatu during the 2011 flight season, just about 10% of the 2010 season. The life cycle of *P. bavius hungarica* is summarized in Fig. 13.

Our field observations confirmed the following plants to be nectar sources for the adults: *Veronica prostrata* L. (Scrophulariaceae), *Fragaria viridis* Duchesne (Rosaceae), *Thymus marschallianus* Willd. (Lamiaceae), and *Euphorbia seguieriana* Neck. (Euphorbiaceae).

Parasites. From the 27 larvae that we studied in the laboratory, six pupated (22%), five were infested with the braconid wasp *Apanteles* sp. and the tachinid fly *Aplomya confinis* (Fallén, 1820), and the rest died of unknown causes.

Myrmecophily. We observed larvae often being visited by ants of the species *Camponotus atricolor* (Nylander, 1849) (det. Marko) (Fig. 5), in contrast to Jutzeler et al. (1997), who found ants of the species *Crematogaster sordidula* (Nylander, 1849) visiting the larvae of *P. bavius hungarica*. Our field and laboratory observations confirm a facultative myrmecophily with the ant *C. atricolor*. Thus, our findings support and

complement the data given by König (1992) and Jutzeler et al. (1997). No *P. bavius hungarica* larva was found on florets infested by aphids.

Acknowledgements

We are grateful to B. Marko, J. Ziegler, A. Taeger, and I. Goia for their help with insect and plant identification and to Jan Habel for critical comments and suggestions on the manuscript. We thank also C. Mihali for the SEMs and to M. Gascoigne-Pees for the *P. bavius hungarica* pupa photo. This work was made possible through financial support of the Sectoral Operational Programme for Human Resources Development 2007–2013, co-financed by the European Social Fund, under the project number POSDRU 6/1.5/S/3 to A. Crisan and the project number POSDRU 89/1.5/S/60189 with the title "Postdoctoral Programs for Sustainable Development in a Knowledge Based Society" to C. Craioveanu. This research was initiated through ID-552 IDEI PNII grants (Bucharest, Romania).

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